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(56) Documents cited

GB A 2072452	GB 1564385	GB 1120393
GB A 2061055	GB 1476450	EP A1 0089148
GB A 2034148	GB 1406685	WO A1 8303683
GB 1603714	GB 1380162	US 4059765
GB 1585364		

(58) Field of search
H5R

(54) Radiation imaging

(57) A detector 1 for the detection of radiation such as X-ray radiation comprises an array of scintillation elements 4 embedded in a sheet 2 of radiation absorbing material. The scintillation elements 4 are monitored individually, for example by a corresponding array of photodiodes, to build up a picture of the incident radiation. The front face of the sheet and the inner walls of the bores 3 may be coated with a reflective material. The detector finds particular application in weld radiography. The detector may be stepped relative to the radiation source, the signals produced by the rows of the detector as they pass a predetermined point being summed.

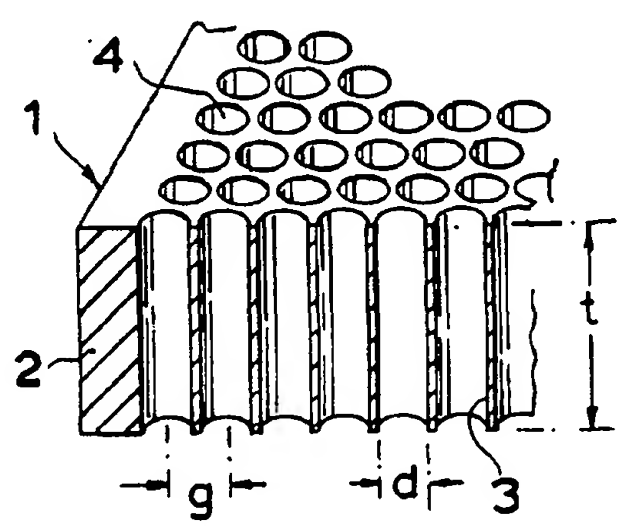

FIG. 1.

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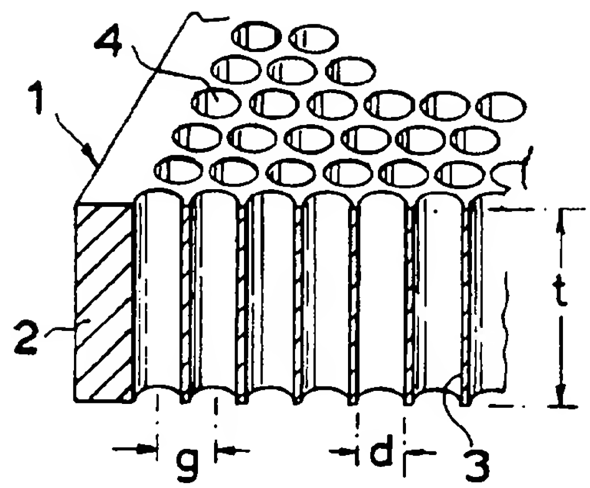

FIG. 1.

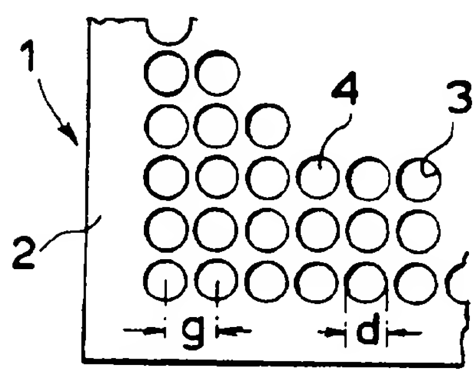

FIG. 2.

SPECIFICATION

Radiation imaging

This invention relates to radiation imaging systems, in particular X-ray radiation, and aims to provide an improved detector for the detection of X-rays. The invention finds particular application in the detection of X-rays transmitted through pipe walls or the like when inspecting welds, allowing for real-time radiography of the welds.

GB-A-1570310 discloses a system in which an X-ray source is positioned inside a pipe to be tested and X-rays transmitted through the pipe wall are detected on a fluorescent screen which is scanned by a video camera to produce a real time display. The display may be stored, and still pictures may also be taken of the fluorescent screen. This system has a number of drawbacks in that it does not lend itself readily to image enhancement techniques or storage of the screen display for analysis, and sympathetic fluorescence in the screen itself limits resolution.

The present invention provides a detector for the detection of radiation such as X-ray radiation comprising an array of scintillation elements. It will be appreciated that the invention is applicable to the detection of any type of radiation utilising a scintillator.

The scintillation elements may be monitored by respective photodiodes. The output frequency of the elements is preferably matched to the peak response of the diodes.

The scintillation elements may be embedded in a sheet of radiation-absorbent material isolating the elements and forming a screen. The front surface of the screen is preferably covered by a thin opaque film of reflective material.

Each element in the screen may be optically coupled to its respective photodiode directly, by a lens or mirror system or by fibre optics etc. As an alternative to a photodiode array the light emitted by the elements may be recorded with a T.V. or film camera etc.

Particularly where a photodiode array is used the output may be digitised to enable immediate storage, retrieval and manipulation using digital image display and processing techniques.

A one or two dimensional array may be used. Where a two dimensional array is used, the array may be stepped through the radiation beam, the response of each row or group of rows elements as they pass a particular point in the subject being summed to produce a time averaged image which will have a reduced noise component and reduced systematic errors arising from differences in the response of the different elements.

A square array may be used. However a hexagonal array will allow for closer packing and in effect overlapping of the elements where the array is stepped through a beam, the alternate rows in the array being summed.

The invention will be further described by way of example with reference to the accompanying drawings, in which,

Figure 1 is a perspective view, partly cut away, of a detector according to one form of the invention; and

Figure 2 is a plan view of the detector of Fig. 1.

A detector 1 comprises a thin sheet 2 of radiation absorbent material such as gold or lead. The sheet 2 is perforated with a regular array of discrete through holes 3 which are each filled with a scintillation material such as Cadmium Sulphide (Silver doped) or Sodium Iodide, forming a scintillation element 4. The type of material used may be varied according to the manner of detecting the light output from the array, for example to produce an output wavelength matched to the peak response of a particular photodiode, T.V. or other system (not shown).

The thickness of the material and the size and spacing of the holes may be chosen to suit a particular application, depending in particular on the resolution required.

The aspect ratio of the scintillators:

diameter (d)/thickness (t)

is chosen to optimise the response to direct, image forming radiation, and to minimise the effects of scattered radiation.

The front surface of the screen, facing the incident radiation, is coated with a thin opaque film of reflective material and the inside wall of each hole 3 is also made highly reflective.

Typical dimensions for the scintillation elements and the screen are as follows:

Screen Width /mm	Length /mm	Element Diameter /μm	Depth /μm	Grid Size /μm	Application
1	10	40	500	50	Small Bore Pipework
4	40	160	1000	200	Large Bore Pipework
200	300	400	500	500	Medical, Large Castings

The grid size is the centre to centre spacing of adjacent elements on a square array. As mentioned other arrays may be used, for example a hexagonal array. It can be seen that the resolution of the detector will depend on the size and spacing of the elements. The typical overall dimensions may of course be varied, but will be limited in part by the control system required to monitor a large number elements.

The array is preferably monitored by an assembly of photodiodes, each optically coupled to a respective element. This assembly may be self scanning, feeding its output directly or *via* a channel plate amplifier to a short term integrating store and then into a digital frame store or via an analogue to digital converter so that the frame store has a digital record of the image intensity, the Z dimension in the X–Y position in the element array. Standard digital image processing and display techniques may then be used on the stored data.

By carefully choosing the aspect ratio (d/t) and orientation of the elements the screen may be made preferentially responsive to direct image forming radiation. Discrimination of the diode output voltage may also be used to enhance the direct/scattered radiation response.

The screens 2, containing the elements 4, may be formed as replaceable units in a detector, to allow changing of screens to suit different radiation patterns and geometries.

Advantages may be gained by reducing the spread of the radiation beam to match the size of the detector, reducing the amount of scatter. The detector and radiation source may be moved or stepped around the subject to build up a complete image.

Arrays may be coupled side by side to cover larger areas.

The detector may be formed by cutting or slicing a crystal of Sodium Iodide into thin sheets of thickness equal to the required element diameter or width and then forming a laminate with an absorbent material such as Gold. The Laminate is then sliced, transverse to the laminated sheets, and the slices reformed into a laminate with further sheets of absorbent material to form a grid as shown, but with square cross section scintillation elements.

CLAIMS

1. A detector for the detection of X-ray radiation, comprising an array of discrete scintillation elements.

2. A detector as claimed in claim 1, comprising a two dimensional array of scintillation elements.

3. A detector as claimed in claim 1 or 2, wherein the scintillation elements are monitored by a corresponding array of photodiodes.

4. A detector as claimed in claim 1, 2 or 3 wherein the scintillation elements are embedded in a sheet of radiation absorbing material.

5. A detector as claimed in claim 4, wherein a front surface of the sheet of material has an X-ray transparent, reflective coating.

6. A detector for the detector of X-ray radiation, substantially as hereinbefore described with reference to the accompanying drawings.

7. Apparatus for weld radiography, including a detector as claimed in claim 1.

8. A method of radiation imaging, comprising illuminating an object to be imaged with radiation and detecting the transmitted radiation with a detector as defined in claim 1.

9. A method as claimed in claim 8, wherein the detector is stepped relative to the incident radiation and signals generated by each row of the array as they pass a predetermined point are summed.

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